Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

LUMINARY Memo #43

To: Dan Lickly, Bill Marscher, Ed Copps

From: George W. Cherry

Date: 16 September 1968

Subject: Implementation of One-Phase Descent Guidance Logic PCR

Tom Gibson has informed me that Mr. Kraft intends to approve the above PCR tomorrow, and that we may start to work on it as soon as we wish. To minimize the impact I think we ought to start rolling immediately. I have attached the implementation agreed upon with MSC last week. I have also suggested personnel assignments to complete the work. (I thought this strawman might help you.)

Bill, we will probably need new engineering initialization verification data and a new test specification. We will certainly need some Level I test data and a modification to Mr. Pu's program. Would you please appoint someone to get together with Jim Kernan to negotiate a new package of data and a need date for 23B.

Dan, the Level III test plan and Level IV test plan will have to be reworked, and new Level III's and Level IV's run. Would you please appoint someone to do this, if you find it necessary.

Distribution:

D. Hoag
R. H. Battin
N. Sears
J. Kernan
P. Plendar
A. Klumpp
D. Eyles
B. Kriegsman
C. Schulenberg
J. Shillingford
B. Covelli

A List of MIT/IL Proposed Changes which Implement the MSC One-Phase Descent Guidance Logic PCR

1. Retain the hi- and lo- gate targets in separate eraseables. (It has previously been pointed out by MSC that the braking phase can be so targetted that the nominal lunar landing trajectory can look exactly like the current two-phase lunar landing trajectory without the guidance sensitivity to navigation just prior to high gate. This targetting selects for Phase 1 a desired state vector near the landing point - - but the desired state vector is so chosen that the nominal trajectory still flies through the old high-gate target. The neat trick here is that TGO does not become small prior to high-gate, and guidance sensitivity remains reasonable.) Implementing the PCR this way allows,
   (a) the current scheme to be used, i.e., the old two-phase trajectory
   (b) the MPAD proposal to be used
   (c) the previous "false hi-gate" proposal to be used

   Action:
   MSC and MIT/IL to specify target conditions for Phase 1 and Phase 2 so that MIT/IL can run mission - like Level IV tests before the FACI. Need date: 24 September 1968.

2. Provide radial acceleration allocation flexibility by a switch which tells the thrust vector orientation routine to allocate the full guidance commanded desired acceleration along the radius vector or, as presently coded, command the thrust vector along the desired total direction.

   Proposed Action:
   Allan Klumpp to provide the equations and Level I test data for implementing this change to 23B. Need date: 16 September 1968.
   Don Eyles to program and test change. Need date for Level II test results: 18 September 1968.
   Bernie Kriegsman to provide GSOP change pages. Need date: 20 September 1968.

3. Use the nominal engine thrust divided by LGC-computed mass for the thrust acceleration. (Thrust acceleration is required for 2. above)

Proposed Action:
MSC to confirm that this is satisfactory. (The alternative is to filter measured thrust acceleration as we do in ascent.)

4. Provide a switch to bypass linear guidance in P 63 during one piece landings.

Proposed Action:
Coding - Don Eyles
GSOP - Bernie Kriegsman

5. P 64 is selected from P 63 by comparison of TGO with a number stored in the LGC. Move this comparison number into eraseable.

Proposed Action:
Coding - Craig Schulenberg or Don Eyles

6. Provide a new extended verb by means of which the astronaut can set the above comparison number to POSMAX causing P 64 and its associated displays and LPD capability to begin within two seconds after the astronaut's request.

Proposed Action:
GSOP change - Jack Shillingford
Coding change - Craig Schulenberg or Don Eyles
Need date: 18 September 1968

7. The landing radar re-position command will be determined by geometry rather than time. This will allow the landing radar to be re-positioned on a logical rather than a chronological basis and allow the selection of P 64 to be selected at the optimum point to bring in P 64 displays, and LPD capability. Specifically, when the vehicle pitch angle goes through a certain value (TBD) the LR will be re-positioned. (The re-positioning will be a one-shot affiar.)

Proposed Action:
Coding - Bob Covelli
GSOP Section IV - Jack Shillingford
GSOP Section V - Bernie Kriegsman
Coding Need Date: 18 September 1968

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
- PROGRAM CHANGE REQUEST -

No. _____
(Completed by FSB)

1.0 COMPLETED BY ORIGINATOR	1.1 ORIGINATOR: Bennett DATE: 9/9/68	1.2 ORGANIZATION: MFAD APPROVAL: _____ DATE: _____
1.3 EFFECTIVITY: Luminary		1.4 TITLE OF CHANGE: Implementation of One-Phase Descent Guidance Logic

1.5 REASON(S) FOR CHANGE:

See attached page.

1.6 DESCRIPTION OF CHANGE:

See attached page.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT	2.1 ☐ APPROVED ☐ DISAPPROVED
2.2 REMARKS:	2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF: _____ DATE: _____
3.0 MIT VISIBILITY IMPACT EVALUATION:	3.1 SCHEDULE IMPACT:
3.2 IMPACT OF PROVIDING DETAILED EVALUATION:	3.3 STORAGE IMPACT:
3.4 REMARKS:	3.5 MIT COORDINATOR: _____ DATE: _____
4.0 SOFTWARE CONTROL BOARD ACTION	4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DISAPPROVED
4.2 REMARKS:	4.3 SOFTWARE CONTROL BOARD SIGN OFF: _____ DATE: _____
5.0 MIT DETAILED PROGRAM CHANGE EVALUATION	5.1 MIT COORDINATOR: _____ DATE: _____

5.2 MIT EVALUATION:

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION	6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR STOP IMPLEMENTATION
6.2 REMARKS:	6.3 SOFTWARE CONTROL BOARD SIGN OFF: _____ DATE: _____

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PROGRAM CHANGE REQUEST NO. _____	PREPARED BY: Bennett DATE: 9/9/68	ORGANIZATION: MPAD

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE ON PROGRAM CHANGE REQUEST FORM)

1.5 REASON FOR CHANGE:

The current descent guidance logic is sensitive to landing radar updates on approaching hi-gate. This can result in erratic attitude and thrust commands depending on the roughness of the approach terrain to the landing sites. For some approach paths (particularly site III-P-11A) attitude excursions (from nominal) on the order of 50° are experienced. For landings to all the Apollo sites attitude excursions of at least 20° will occur. Excursions in thrust (from throttleable region to FTP and back) also occur. These attitude and thrust excursions do not prevent a safe landing but neither do they enhance a safe landing. Crew monitoring tasks as well as ground monitoring are more difficult. Also, aborts from these off-nominal attitudes drop dangerously close to the lunar surface before achieving safe orbit.

The sensitivity of the guidance logic to landing radar updates is further undesirable in view of MSFN and onboard navigation uncertainties (particularly downrange), approach terrain uncertainties, and landing radar performance uncertainties. Unfortunately, these quantities may not be defined any better before the lunar landing mission. Thus, it is deemed advisable to desensitize the descent guidance logic to landing radar updates.

1.6 DESCRIPTION OF CHANGE:

The descent guidance logic is to be changed to remove the hi-gate target and implement the vertical acceleration control while operating at the FTP, thus desensitizing the effects of terrain updates and low engine performance. The effect of this change is to combine P-63 and P-64 into one program.

REMARKS